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EXAMINER	
KENNEDY, JENNIFER M	
ART UNIT	**PAPER NUMBER**
2812	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/982,953	Applicant(s) MCTEER, ALLEN	
	Examiner Jennifer M. Kennedy	Art Unit 2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspond nce address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *23 April 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *22-35 and 58* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *22-35 and 58* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

In view of Applicant's amendment to the specification, the objection is withdrawn.

In view of Applicant's argument with respect to the priority, the objection is withdrawn.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 22-35 and 58 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chiang et al. (U.S. Patent No. 5,739,579) in view of Moslehi et al. (U.S. Patent No. 6,016,000).

In re claim 22, Chiang et al. disclose the method of forming a copper interconnect structure providing electrical connection for a semiconductor device (see column 5, lines 25-31, and column 12, line 64 through column 13, line 5), comprising the steps of;

forming a first contact opening into a first insulating layer (391) formed over a semiconductor substrate (320);

forming a conductive plug in the first contact opening (394);

forming a second insulating layer (395) over the conductive plug and said first insulating layer;

forming a second contact opening in the second insulating layer;

forming a barrier layer (396) in the second contact opening;

forming a copper conductor (397) over the barrier layer; and

forming a passivation layer on an upper surface portion of the copper conductor, the passivation layer being a continuous layer, (see column 21, lines 35-50 , and column 20, lines 24-33, the method explained in detail with reference to the lower interconnect layer, the details given in column 12, line 53, through column 20, line 24 see also for example passivation layers 80 and 98 formed as continuous layers).

Chiang et al. does not disclose the method of forming the heat-radiating passivation layer of aluminum nitride, wherein said heat-radiating layer is formed from approximately 100 angstroms to approximately 1000 angstroms thick.

Moslehi discloses the method of forming the heat radiating passivation layer of aluminum nitride, wherein said heat-radiating layer is formed from approximately 100 angstroms to approximately 1000 angstroms thick (see column 14, lines 16-60, and column 15, lines 1-24).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the passivation layer of aluminum nitride, since as Moslehi teaches AlN is an alternative choice to that of the silicon oxide passivation layer (Moslehi, column 14, lines 16-25) formed in Chiang et al. Further, AlN has the

advantage of high thermal conductivity (see column 14, lines 16-60, and column 15, lines 1-24, specifically the passivation layer formed in lines 16-25 of column 14). The examiner notes that heat-radiating effects of the aluminum nitride is an intrinsic material property of the aluminum nitride, and thus the aluminum nitride layer of Moslehi as incorporated into Chiang et al. would have acted as both a passivation layer and a heat radiating layer.

In re claim 23, Chiang et al. also disclose the method of chemical mechanical polishing (CMPing) the copper layer and the barrier layer (see column 20, lines 1-3).

In re claim 24, Moslehi discloses the method of cleaning the upper surface portion of the copper conductor prior to the formation of the aluminum nitride layer (see column 12, lines 32-35) in order to remove contaminants from the surface.

In re claim 25, neither Chiang et al. nor Moslehi explicitly disclose the method wherein the aluminum nitride is formed to a thickness of approximately 300 angstroms. It would have been obvious to one having ordinary skill in the art at the time the invention was made to form the aluminum nitride to a thickness of 300 angstroms, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller,* 105 USPQ 233. The inter-electrode capacitance and thus, the speed of the device overall, is dependent on the thickness of the passivation layer. Therefore the passivation layer's thickness is a result effective variable. In addition, the selection of the aluminum nitride thickness is obvious because it is a matter of determining optimum process conditions by routine experimentation with a limited number of species of result

effective variables. These claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re Woodruff, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also In re Huang, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996)(claimed ranges or a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill or art) and In re Aller, 105 USPQ 233 (CCPA 1995) (selection of optimum ranges within prior art general conditions is obvious). Note that the specification contains no disclosure of either the critical nature of the claimed thickness or any unexpected results arising therefrom. Where patentability is said to be based upon a particular chosen thickness or upon another variable recited in a claim, the Applicant must show that the chosen thickness is critical. *In re Woodruf*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990). See also MPEP 2144.04(IV)(B).

In re claim 26 and 27, Moslehi discloses the method of by sputtering deposition (see column 14, lines 16-60 and column 15, lines 1-24.

In re claim 28, Chiang discloses the method wherein the barrier layer is formed of a refractory metal compound being selected from the group consisting of refractory metal nitrides, refractory metal carbides, and refractory metal borides (see column 19, lines 4-10).

In re claim 29, Chiang et al. disclose the method of forming an interconnect structure providing electrical connection for a semiconductor device (see column 5, lines 25-31, and column 12, line 64 through column 13, line 5), comprising the steps of;

forming a contact opening in an insulating layer (395) of said device;

depositing a conductor (397) within said contact opening; and

forming a passivation layer on an upper surface portion of said conductor (see column 21, lines 35-50, see column 20, lines 24-33, the method explained in detail with reference to the lower interconnect layer, the explanation given in column 12, line 53, through column 20, line 24).

Chiang et al. does not disclose the method of forming a heat-radiating passivation layer of aluminum nitride, the heat radiating layer providing a heat dissipating path for the conductor, wherein said heat-radiating layer is formed from approximately 100 angstroms to approximately 1000 angstroms thick.

Moslehi discloses the method of forming a heat-radiating passivation layer of aluminum nitride, the heat radiating layer providing a heat dissipating path for the conductor, wherein said heat-radiating layer is formed from approximately 100 angstroms to approximately 1000 angstroms thick (see column 14, lines 16-60, and column 15, lines 1-24).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the passivation layer of aluminum nitride, since as Moslehi teaches AlN is an alternative choice to that of the SiO_2 passivation layer (Moslehi, column 14, lines 16-25) formed in Chiang et al. Further, AlN has the advantage of high

thermal conductivity (see column 14, lines 16-60, and column 15, lines 1-24, specifically the passivation layer formed in lines 16-25 of column 14). The examiner notes that heat radiating and heat dissipating effects of the aluminum nitride is an intrinsic material property of the aluminum nitride, and thus the aluminum nitride layer of Moslehi as incorporated into Chiang et al. would have acted as both a passivation layer and a heat radiating layer.

In re claim 30, Chiang et al. also disclose the method of forming a barrier layer (396) in said contact opening and before said step of depositing said conductor.

In re claim 31, Moslehi discloses the method of cleaning the upper surface portion of the copper conductor prior to the formation of the aluminum nitride layer (see column 12, lines 32-35) in order to remove contaminants from the surface.

In re claim 32, neither Chiang et al. nor Moslehi explicitly disclose the method wherein the aluminum nitride is formed to a thickness of approximately 300 angstroms. It would have been obvious to one having ordinary skill in the art at the time the invention was made to form the aluminum nitride to a thickness of 300 angstroms, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller,* 105 USPQ 233. The inter-electrode capacitance and thus, the speed of the device overall, is dependent on the thickness of the passivation layer. Therefore the passivation layer's thickness is a result effective variable. In addition, the selection of the aluminum nitride thickness is obvious because it is a matter of determining optimum

process conditions by routine experimentation with a limited number of species of result effective variables. These claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re Woodruff, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also In re Huang, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996)(claimed ranges or a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill or art) and In re Aller, 105 USPQ 233 (CCPA 1995) (selection of optimum ranges within prior art general conditions is obvious). Note that the specification contains no disclosure of either the critical nature of the claimed thickness or any unexpected results arising therefrom. Where patentability is said to be based upon a particular chosen thickness or upon another variable recited in a claim, the Applicant must show that the chosen thickness is critical. *In re Woodruf*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990). See also MPEP 2144.04(IV)(B).

In re claim 33 and 34, Moslehi discloses the method of by sputtering deposition (see column 14, lines 16-60 and column 15, lines 1-24.

In re claim 35, Chiang discloses the method wherein said conductor is selected from the group consisting of aluminum, gold, silver, tungsten, and copper (column 21, lines 25-30).

In re claim 58, Chiang et al. disclose the method of forming a copper interconnect structure providing electrical connection for a semiconductor device (see column 5, lines 25-31, and column 12, line 64 through column 13, line 5), comprising the steps of;

forming a first contact opening into a first insulating layer (391) formed over a semiconductor substrate (320);

forming a conductive plug in the first contact opening (394);

forming a second insulating layer (395) over the conductive plug and said first insulating layer;

forming a second contact opening in the second insulating layer;

forming a barrier layer (396) in the second contact opening;

forming a copper conductor (397) over the barrier layer; and

forming a passivation layer on an upper surface portion of the copper conductor, the passivation layer being a single continuous layer, (see column 21, lines 35-50 , and column 20, lines 24-33, the method explained in detail with reference to the lower interconnect layer, the details given in column 12, line 53, through column 20, line 24, see also for example passivation layers 80 and 98 formed as continuous layers).

Chiang et al. does not disclose the method of forming the heat-radiating passivation layer of aluminum nitride and wherein said heat-radiating layer is formed from approximately 100 angstroms to approximately 1000 angstroms thick.

Moslehi discloses the method of forming the heat radiating passivation layer of aluminum nitride, wherein said heat-radiating layer is formed from approximately 100

angstroms to approximately 1000 angstroms thick (see column 14, lines 16-60, and column 15, lines 1-24).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the passivation layer of aluminum nitride, since as Moslehi teaches AlN is an alternative choice to that of the silicon oxide passivation layer (Moslehi, column 14, lines 16-25) formed in Chiang et al. Further, AlN has the advantage of high thermal conductivity (see column 14, lines 16-60, and column 15, lines 1-24, specifically the passivation layer formed in lines 16-25 of column 14). The examiner notes that heat-radiating effects of the aluminum nitride is an intrinsic material property of the aluminum nitride, and thus the aluminum nitride layer of Moslehi as incorporated into Chiang et al. would have acted as both a passivation layer and a heat radiating layer.

Response to Arguments

Applicant's arguments with regard to the rejections under 35 U.S.C. 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicant's argument concerns that Chiang et al. teaches the use of a passivation layer that acts as a diffusion barrier layer while, Moslehi teaches a free-space ILD/IMD structure that eliminates the need for the use of diffusion barrier layer at each interconnect level, and thus the copper can be deposited directly on the patterned structure without the need for the diffusion barrier layer.

Applicant point to the diffusion barrier 60 of Chiang et al. as the diffusion barrier to copper. The examiner notes that only the top passivation layer (over the uppermost interconnect layer) described in column 21, lines 35-50 was relied on to show the passivation layer. The examiner notes that this passivation layer would be formed on top of the copper interconnect. On the other hand, Moslehi has eliminated the need for diffusion barriers between the underlying interconnect layers and the copper formed thereon, but still requires upper passivation layers (see column 14, lines 16-60, and column 15, lines 1-24, specifically the passivation layer formed in lines 16-25 of column 14).

Finally, the examiner maintains that the while the passivation layer of Chiang et al. acts as a diffusion barrier layer it also acts as a passivation layer. The Applicant assert that Chiang's silicon oxynitride passivation layer is primarily used as a diffusion barrier. It is uncertain how applicant came to this conclusion reading Chiang column 21, lines 35-49, however the examiner agrees that the passivation layer can be used as a barrier layer, however it may also act as a passivation layer, preventing moisture and contamination. The examiner only relied upon the fact that a passivation layer was formed. The fact that the passivation layer had additional benefits and uses in the Chiang et al. reference is irrelevant. Moslehi teaches the use of aluminum nitride as a passivation layer. The examiner respectfully points out that the Moslehi reference was used for the teaching of the top passivation layer of AlN. Moslehi was not used for the teaching of barrier layers between the interconnect levels.

The examiner notes that proper motivation was provided. It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the passivation layer of aluminum nitride, since as Moslehi teaches AlN is an alternative choice to that of the silicon oxide passivation layer (Moslehi, column 14, lines 16-25) formed in Chiang et al. Further, AlN has the advantage of high thermal conductivity (see column 14, lines 16-60, and column 15, lines 1-24, specifically the passivation layer formed in lines 16-25 of column 14). The examiner notes that heat-radiating effects of the aluminum nitride is an intrinsic material property of the aluminum nitride, and thus the aluminum nitride layer of Moslehi as incorporated into Chiang et al. would have acted as both a passivation layer and a heat radiating layer.

The applicant also argues that the passivation layer of Moslehi hermetically seals the interconnect structure and comprises three layers. The examiner notes that the claim language "comprising" does not preclude additional layers or steps. Further, the examiner notes that the AlN layer is clearly referred to as a passivation layer and the fact that the material can be used to perform additional functions such as a sealing layer is not relevant.

The applicant also argues that the AlN layer is not a heat radiating layer. Moslehi clearly discloses the layer is highly thermal conductive, and the examiner points out that the material is the same of that of the applicants "heat radiating layer", namely AlN. The examiner notes that heat-radiating effects of the aluminum nitride is an intrinsic material property of the aluminum nitride, and thus the aluminum nitride layer of Moslehi as

incorporated into Chiang et al. would have acted as both a passivation layer and a heat radiating layer.

Furthermore, applicant argues that the cited references are directed to solving different problems. The fact that the two references are teaching inventions that solve two different problems does not mean that the references are not combinable. Moslehi and Chiang et al. are analogous art, teach in combination every limitation claimed and the examiner has provided a motivation for combining the two references above.

Further the examiner notes that Moslehi does indeed teach a AlN passivation layer (column 14, lines 20-25). The examiner acknowledges that silicon oxide is also disclosed as a material choice for the passivation layer. Teaching another way is a broad concept. It refers to a situation where a reference teaches a preferred, a better, or an alternative way to a claimed way of accomplishing something. A reference must be considered for all it teaches. *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F .2d 281, 296, 227 USPQ 657, 666 (Fed. Cir. 1985). Preferred embodiments and disclosed examples do not constitute a teaching away form a broader disclosure or nonpreferred embodiments. *Merck & Co. v. Biocraft Labs.*, 874 F2d 804, 807, 10 USPQ2d 1843, 1846 (Fed. Cir. 1989); *In re Mills*, 470 F .2d 649, 650, 176 USPQ 196, 198 (CCPA 1972). Similarly, a statement that a first product is somewhat inferior to another product for the same use does not teach away when the reference also discloses that the first offers acceptable advantages. *In re Gurley*, 27 F. 3d 551, 553, 31 USPQ2d 1130, 1131 (Fed. Cir. 1994). The examiner maintains that Moslehi

recognizes that aluminum nitride is an acceptable passivation layer that has the advantages of passifying the copper interconnect.

Finally, in regards to the claimed thickness of the aluminum nitride layer, the examiner notes that the specification contains no disclosure of either the critical nature of the claimed thickness or any unexpected results arising therefrom. Where patentability is said to be based upon a particular chosen thickness or upon another variable recited in a claim, the Applicant must show that the chosen thickness is critical. _In re Woodruf_, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jennifer M. Kennedy whose telephone number is (571) 272-1672. The examiner can normally be reached on Mon.-Fri. 8:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Niebling can be reached on (571) 272-1679. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

jmk

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